On the Dynamics of Air and Water Vapor at Supercritical Temperatures

15 June 2025
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Introduction

Supercritical gasses and their property of efficient conduction of heat have not been sufficiently studied and open up tantalizing possibilities for the transport of heat. This publication will make predictions about the behavior and dynamics of supercritical gas-liquid mixtures.

Abstract

Supercritical gasses which have been observed under experimental conditions have, to this author's knowledge, always contained some proportion of water vapor. Perhaps the most important prerequisite for bringing about the most sought-after property of supercritical gasses is the presence of both water vapor and air. Air, in isolation, could be predicted not to exhibit enhanced heat-conduction properties. This is significant and, in fact, essential to understanding the dynamics at work in a supercritical gas. This means that referring to such as a "supercritical gas" is a misnomer; if a popular one; as all supercritical gasses are actually air-water mixtures.

It is said that water vapor is "carried" by the air and that atmosphere has a specific "carrying capacity" for water vapor. As the temperature of a gas increases, its density decreases and its carrying capacity for water vapor increases, as any student of meteorology could attest. However, when the gas reaches the supercritical state, the efficiency with which heat is conducted increases dramatically. I propose that this is due to an inversion in the dynamic between the air component and the water vapor component.

In ordinary precipitation, nucleation leads to the formation of water globules which eventually become too heavy to be supported by wind currents. An air-water separation transpires in the supercritical transition, however, this separation is not driven by nucleation. In fact, nucleation and globularization of water molecules would be extremely unlikely in the supercritical state. I would posit that the water molecules become aligned and that the water molecules i.e. their V-shape enables them to be nested and therefore to mutually repel/propel one another, begin to convect, moving through the supercritical gas with little to no resistance due to the combination of the low density of the gas and the way in which the water molecules may ride in one-another's wake. As they move, they resemble a series of chevrons in close proximity which point like arrows in a particular direction, following like ducks in a row. The thermal conduction in a supercritical atmospheric mixture, I propose, is entirely carried by the aqueous and not by the gaseous component. The force separating the water from the gas, given the lack of interaction, is more esoteric.

These conveyor belts of water molecules circulate and resemble, in many ways, magnetic field lines. In the space within these convecting flows of

water molecules, air molecules circulate in the opposing direction, interacting only marginally with the water molecules. Fundamentally, the water molecules are forced out of the gaseous portion of the mixture due to the high number of individual turbulations of the gas each second. The gas behaves as do fine particles of sand in a mixture of large and small particles of sand left to sit in a container over a long period of time (or a short time when aided by vibration.) The water, in this analogy, behaves like the coarse particles of sand which, when given time, separate, leading to the fine particles settling to the bottom of the jar and the coarse molecules rising to the top. It could be also be said that in this condition, the gas-liquid mixture behaves like a bubble made of liquid in a sea of air as opposed to a bubble made of air in a sea of liquid. *This inversion of the relationship between air and liquid is made possible by entropy-induced negentropy.* As each movement of gaseous molecules in the mixture is more likely than not to force water molecules out and to favor globularization of air (rather than vice versa,) although the effect is minute for each individual movement, the sheer number of times that gaseous molecules move about in such a mixture is sufficient to counteract the significant electroweak repulsion of the water molecules with respect to one-another. This forces the gaseous portion of the mixture to globularize (much as water droplets do under normal conditions) and forces the water component to organize in constantly-circulating streams.

This inversion of the dynamic between gas and liquid at such high temperatures could be predicted to have other interesting manifestations. For example, a droplet of water condensing on the walls of a chamber containing supercritical atmosphere would cease to resemble droplets after the transition to supercriticality and would become concave, resembling a series of dimples as on the side of a golf ball. In the case of fluid accumulating on the walls of a pressure chamber, it would be impossible for water to drip from the roof of the chamber. It would simply adhere to the roof of the chamber and would remain mostly stationary, more closely resembling waves on the ocean than beads of condensation in the supercritical state.

Supercriticality at Lower Temperatures Through Enhanced Geometric Contrast

Fundamentally, it is the shape of the molecules (i.e. N2 and O2 are linear whereas H2O is V-shaped) which allows for this dynamic to exist at high temperatures whereas thermal energy and the geometric relationships between these molecules allows for an indirect transference of energy (thermal energy-to-entropy-to-negentropy) which culminates in the effective densification and acceleration of the water molecules, creating convective systems of high efficiency.

In order to reduce the transition temperature, chains of heat-durable molecules with the same geometric shape as water might be used whereas the primary difference would be that the water-substitute would feature substantially increased physical size. At a larger scale, supercritical effects may be seen at lower temperatures and the stratification of such a proposed synthetic solution would be easier to bring about. Furthermore, the convective velocity of the water-like component would likely be higher, to some extent.

If we think of the mixture in terms of buoyancy, when an object is floating on water, its volume relative to its weight determines buoyancy. The larger a ship is, the heavier it can be and still remain afloat. Fundamentally, supercriticality ought to be thought of as the separation of air and water vapor in the absence of nucleation. Because this unique type of air-water separation is based upon geometry rather than other factors, the larger the size of the V-shaped molecules, the greater the relative disparity of geometry. This disparity works hand-in-glove with entropy to produce negentropy, which allows for the water-like component to consistently fall into statistically unlikely configurations (like a pin landing on its head and remaining this way.) The greater the number of entropic events in the gaseous component, the greater the negentropy of the aqueous component. The greater the disparity of geometry, the fewer entropic events are required in order to induce negentropy in the secondary component and the lower the transition temperature. Furthermore, it could be predicted that mixtures of N_2 and O_2 may provide some benefit in terms of prompting molecular activity and therefore entropy rather than either gas in isolation.

Conclusion

With experimentation, it should be possible to determine to what extent the point of supercriticality may be reduced by substituting the water component with synthetic molecules. Within a closed system, a supercritically-heated synthetic gas-fluid mixture with similar comparative geometries between N_2 and H_2O excepting that the scale of the H_2O-like molecule is amplified should allow for the efficient and rapid conduction of heat over great distances with reduced requirements for heat input. In order to be practical, such a system should be insulated on all sides except at the ends. Such a system could be used to draw heat away from a heat-producing system (as in deep-geothermal energy extraction) or could be used to introduce heat into a system from a great distance as one might wish to do in a smelting facility or an electrical-generating facility which relies upon the boiling of water to move turbines (for instance, uranium fuel rods could be directly connected with supercritical conduction rods which increase the surface area which contacts with the water to be boiled in that electrical-generation process.